Logo

Description automatically generatedRequirement analysis and specification document

*Davide Li Calsi 10613807*

*Andrea Alberto Marchesi 10577090*

*Marco Petri 10569751*

Professor: Matteo Giovanni Rossi

Academic year: 2020/2021

Contacts:

Davide Li Calsi [davide.li@mail.polimi.it](mailto:davide.li@mail.polimi.it)

Andrea Alberto Marchesi [andreaalberto.marchesi@mail.polimi.it](mailto:andreaalberto.marchesi@mail.polimi.it)

Marco Petri [marco.petri@mail.polimi.it](mailto:marco.petri@mail.polimi.it)

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**No index entries found.**

# Introduction

1

Virus SARS-Cov-2 has influenced the whole world during 2019 and 2020 and continues to influence it. Several governments across the world decided to take restriction measures to avoid the infection. The system to be should work in order to make store’s customers able to line up digitally to enter a grocery store, or to make a reservation for a given time on a given day. This part of the document explains the purpose of the project, the scope, definitions and acronyms used, document’s revision history, reference documents and the document structure.

## Purpose

The system is aimed to be used on the Italian territory for a grocery store’s chain by customers of the stores. The system’s purpose can be divided in two different categories:

* **Service for customers**: a service is offered to grocery stores’ clients and is realized with a digital system. The service must allow users to queue online in order to access the store until is their time of entering and to book visits to the store later than at the time of reservation;
* **Avoiding crowds**: avoiding crowds is the aim of the system which is intended to substitute when possible the classical lining up methods (tickets and queues).

The system is intended to be easily usable and accessible almost to everyone who has access to an electronic device where external applications can be installed. No hardware design is requested and customers use their own devices. The system can be used by the user to queue and to see how much wait time there is to achieve the possibility to enter the store. These two system’s characteristics are used to ensure the goal of having the minimum amount of people waiting outside the store to be able to enter on it.

The system should be able to trace customers visits and to save customers mean visit time and store it for future computations. Once the system has traced a certain number of visits of a customer, it will be able to estimate the visit duration time for it and use this estimation to compute the number of people able to access the market at that visit time. The system should trace every customer which visits the store and save the visits durations in order to be able to compute the mean time of a visit for that client.

The system should be possible to be used parallelly to a physical system of lining up at the store’s entrance for those people who cannot afford the application due to technology limitations. The system goal is to balance the digital queue with physical queue of people which cannot use the digital system.

Goal of the system can then be summarized as follows:

* Goal 1: customers can queue online without reaching the store online;
* Goal 2: customers can make a reservation for a store registered in the system;
* Goal 3: customers can choose their preferred store by the all present;
* Goal 4: customers must be safe during their visit at a store;
* Goal 5: customers must be able to buy whatever they need at a store;
* Goal 6: every customer must be allowed to queue aiming to enter in a store;
* Goal 7: no crowds have to be present outside the store;
* Goal 8: customers who queue first are the first to enter the store;
* Goal 9: precise estimation of the waiting time must be accessible to the queuing customers;
* Goal 10: customers receive a notification when they need to get out in order to reach the store;
* Goal 11: customers cannot overload a store's queue;
* Goal 12: system is configurable for the needs of every store;
* Goal 13: customers' access must be supervised.

## Scope

The system is put on an environment composed of different entities which are part of the world: customers, store and checkpoint controllers. System is used by different entities like customers, security staff and the store. With checkpoint controllers we mean the people involved in the activity of controlling people’s numbers when a number is called and a person approaches the entrance wanting to be granted to access.

It follows the list of world (only) phenomena:

* Customer selects a store to buy things;
* Customer opens the application;
* Customer goes to the store;
* Customer shows its number to checkpoint controller;
* Customer takes its shopping items;
* Customer pays.

It follows the list of shared phenomena:

* The store sets the maximum amount of people for a group;
* The store sets the maximum amount of people inside a certain sector;
* Customer enters in the (digital) queue;
* Customer checks the estimated waiting time;
* Customer books a visit;
* Customer inserts the items or items’ categories in to-buy list;
* Customer inserts the approximate duration of the visit;
* Customer receives an alert about the time needed to get to the store;
* Customer receives a list of alternative time slots;
* Customer receives a list of alternative stores;
* Customer receives a notification of a free slot;
* Customer shows the QR code representing their number to the checkpoint controller;
* Customer shows its QR code;
* Checkpoint controllers controls a QR code shown by a Customer.

It follows the list of machine phenomena:

* System computes the number of a client;
* System calls a number;
* System verifies if a number is the number of the customer which should enter;
* System computes the estimated waiting time (for each customer);
* System computes mean duration of a visit for a long-term customer;
* System evaluates the distance between the customer and the store;
* System finds alternative time slots;
* System finds other near stores.

## Definitions, acronyms and abbreviations

Definitions:

* **Category:** a set of products with similar characteristics;
* **Checkpoint:** a point at which ticket and temperature checks are performed;
* **Checkpoint controller:** a worker who performs checkpoint checks;
* **Customer**: is a person which wants to visit the store in order to buy items;
* **Item**: a product which is sell in a store;
* **Queue:** it is the queue that customers need to be in before entering a store (FIFO);
* **Queue display:** a screen displaying the number of the ticket whose holder is to be admitted into the store;
* **Sector:** a store’s well defined area where products of certain category are stored;
* **Store manager**: is a worker of a specific store at which is granted the access of store’s parameters modification service;
* **Ticket:** it can be digital or paper based. It contains a unique QR code used for verification and a number indicating the position in the queue;
* **Ticket machine:** a machine that provides tickets.

Abbreviations:

* **OS:** operating system;
* **S2B**: system to be;

## Revision history



## Reference documents

1. http://dati.istat.it/Index.aspx?DataSetCode=DCCV\_ICT

## Document structure

# Overall description

2

The overall description is the part of the RASD document where is explained and specified at a high level what are the requirements and the functions to be realized by the system. This section contains some UML models which explains the machine and world for the project. The product perspective paragraph explains the scenarios and the behaviour at a high level of the entities involved in the system’s scope. The product function contains an explanation of the requirements which must be fulfilled by the system. The user characteristics section details how each user of the system acts.

## Product perspective

The following scenarios are all set during a viral outbreak.

Scenarios:

* An elderly woman, who does not have internet access from home, is running out of food and needs to go shopping for groceries. Once she arrives at her favourite store, she retrieves a ticket from the ticket machine by pushing a button. She observes the queue display waiting for her number to appear while making sure she stays at safe distance from other people. Once her number appears she proceeds to the checkpoint to be controlled. She passes the controls, finishes shopping, and heads home.
* A family of three composed of a father, a mother, and a 4 years old child, needs to buy supplies for the whole family. The father logs in the web app from his phone and starts booking a ticket for their favourite store. Since they will go altogether, he specifies that the ticket is for a group of three people. He then selects the store, the date, and the time as it is suggested by the application. Since they already know what to buy, he inserts the categories of the items to buy. Finally, the father inserts the chosen way to reach the grocery store. When it’s time for them to head there, they receive a notification to remind them. They arrive at the store on time and proceed to the checkpoint. The checkpoint controller performs the usual controls and lets them all in together since their ticket is for three people. They complete their purchases and head home.
* The manager of a small grocery shop wants to change the opening hours of his shop. He logs in his store’s account on his pc, and he sets the new hours from the console. He then realizes that since he has recently reorganized the dairy section, more people can safely be in there. He therefore also increases the maximum number of people in that section. He saves the changes and keeps on with his day.
* A worker of a bakery is tasked to be the checkpoint controller of his store. He needs to make sure that the customers respect the queue. To do so, he scans the QR code on every customer’s ticket with his phone. A girl approaches and hands him her phone displaying the QR code. He scans it, his app confirms the code validity, and he lets the girl in. Then a woman approaches him with a paper ticket from the ticket machine. He scans it but this time the code is not valid, as that number is yet to be called. He tells the woman to wait for her number to be displayed on the queue display and keeps on working.
* An elderly man has been shopping using the ticket machine to get his tickets. He realizes that it would be both more convenient and safer for him to use the web app from home. He would avoid unnecessary waiting time in the supermarket. This leads him to buy a new smartphone with a data plan included. He rapidly makes it to the web app by using the phone’s default browser. Once there, he is guided to register by a very simple and clear UI. During the registration, he inserts personal information. Finished the registration he starts using the app by booking a visit to his favourite store.

Diagram

Description automatically generated

The application domain model is composed of different actors, the main actors are the customers, the checkpoint controllers and the stores’ manager. The first can visit stores multiple times both visiting it by booking a visit and by either queuing online or physically. After the turn of the customer has been called it can enter the supermarket, however in order to be allowed to access it, it must show its QR code to the checkpoint controller. The checkpoint controller uses a QR Reader on a mobile device which gives it the information about the possibility of the customer to enter the supermarket. Every QR code is related to a visit of a customer to a supermarket and its code is unique and composed of a number and a date. Here we show a top-level class diagram of the application involving all actors which are recorded by the system.

The system is composed of different actors as we can see in the class diagram. The behaviour of the system and its actors is expressed using UML State Diagrams as formalism to represent machines’ states.

Diagram

Description automatically generated

Figure 2.1

Customers can arrive to the supermarket with three reasons: taking a ticket, arriving because of a booking or arriving because its digital turn is going to be called or has called. In this diagram (figure 2.2) is described customer’s state diagram while arriving to the supermarket in order to enter it having a booking number or a queue number.

Diagram

Description automatically generated

Figure 2.2

Customers can queue online in order to avoid doing a physical line. This customer’s state diagram (figure 2.3) represents the customer involved in the activity of taking a number in the digital queue is describe here above.

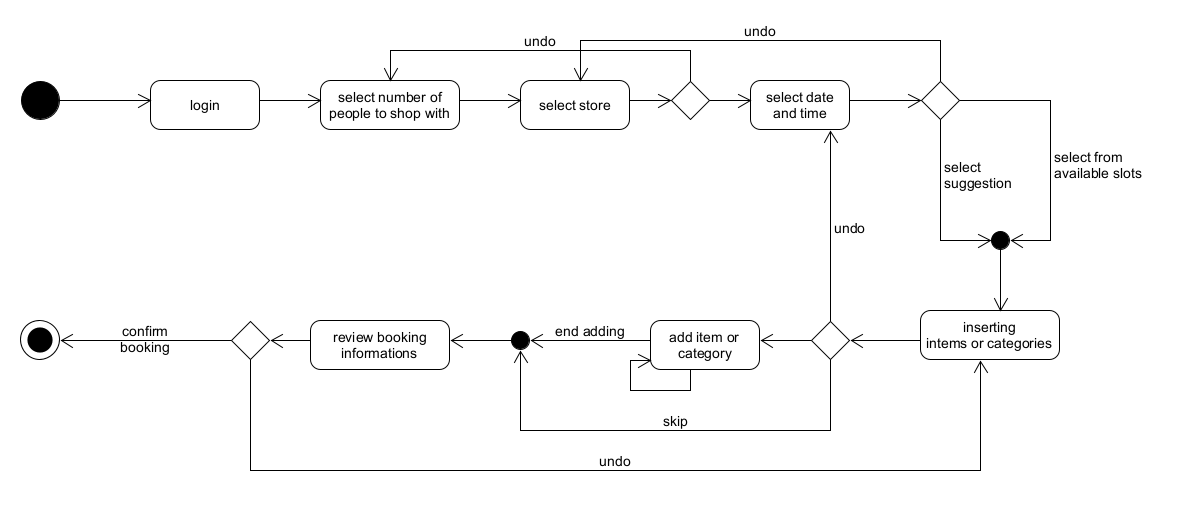


Figure 2.3

Customers can also book a visit instead of queueing. They can do it from the web app and diagram (figure 4) describes this process.

Diagram

Description automatically generated

Figure 2.4

When customers are unable use the web app, they can use the ticket machine instead, but for queueing only. The diagram (figure 2.5) describes the process that ticket machine users have to go through to be admitted into the store.

Diagram

Description automatically generated

Figure 2.5

Checkpoint controllers have the role of controlling every ticket of the customers which reach the supermarket and want to enter. Their state machine diagram (figure 2.6) expresses how they evolve while doing this specific activity. They control ticket until they must do that.

Diagram

Description automatically generated

Figure 2.6

Store managers can modify parameters regarding their store from the web app. The diagram (figure 2.7) shows how they can do it.

## Product functions

The system will provide useful functionalities to both customers and store managers/checkpoint controllers.

The main customer-oriented functions are **remote queuing** and **booking a visit.**

The first functionality consists in *letting the customer join a digital queue* for a given store by providing the customer (upon request via their device) a valid digital ticket. Such ticket is the union of a waiting number plus a QR code aimed at proving the validity of the ticket itself. In order to obtain their ticket, customers will have to select a store *from a digital map that displays all available stores* within their surroundings. Before the number associated with their ticket is called by the store, customers will also be able to see *an estimate of their waiting time*, dynamically calculated by the system and displayed on their device. The system will also *notify customers when they should leave* from home to get to the store: such notification will be planned by the system based on an estimation of the time that a customer might take to arrive at the store. In addition to that, the backend will be in charge of avoiding an excessive number of people in the store. In order to do so *the system will not call a new number unless there is a free spot* in the store.

The latter function permits a customer to plan and *book a visit in advance*, opposed to the remote queuing function whose role is the management of short-time queues. Customers who select this option will have to specify a store for their purchases among the ones displayed in the same map as before. Then the system will *display a time-table with all the available and occupied time slots* in the store, for the user to choose the most suitable one. The system will also send the user a *list of alternative solutions*, both possible pre-defined time slots or alternative stores for their purchases. Regardless of the option that they choose, the system will send customers a QR code that shall be shown upon entering the store. Customers also have the option functionality of *providing a list of items that they intend to buy*, for more accurate estimations. If the customer is not able to provide a list of items if can optionally *provide a list of categories of items they intend to buy*.

In any case, the system will not accept a QR code that has already been used for a valid entrance: once the customer has entered he or she will need a new ticket or booking in order to re-enter.

On the other hand, the system will also provide some key **configuration functionalities** to store managers. They will in fact be able to *set some core parameters* in order to regulate fluxes and clusters of people within their store: e.g. they will decide how many people are permitted to stay within one group, how many customers are allowed to stay in a given store section, the duration of time slots and so on. Furthermore, one or more checkpoint controllers will have access to a **QR scanning functionality**, in order to scan the QR codes of employees and customers to monitor their access. Scanning a QR code will *establish whether it is valid or not* and will automatically make it non-reusable.

Finally, the system will provide general purpose functionalities to all of its users, such as **registering, login, account management…** Distinction will be made between regular customer accounts, checkpoint controller accounts and store manager accounts. Each user will obviously have *access to the functionalities of their role only* e.g.. customer will only have access to customer-oriented functionalities.

## User characteristics

This section presents the users and their characteristics:

* **Store Managers**
  + They are in charge of their store’s organization. In particular, they decide the opening hours and the logistics regarding the customers.
* **Customers**
  + They can be of any demographics. Shopping for groceries is a need that everybody has;
  + Their ability to interact with technology varies greatly. While younger generations are accustomed to technology the elderly might struggle to use complex applications;
  + They may have internet at home as well as they may not. Even though in developed countries the vast majority of customers are expected to have internet access at home, a sizable portion still doesn’t. According to a 2020 statistic, in Italy 76% of households have it;[1]
  + Normally customers go grocery shopping with a least a vague idea of the items to buy;
  + The time spent in the store by customers varies greatly. It can usually be loosely predicted by the customers;
* **Checkpoint controllers**
  + They have a mobile devices used to scan QR codes;
  + They are workers who control the flow of customers at the entrance of the store;
  + They may grant access to customers as well as they may disallow customers to enter the grocery store.

## Assumptions, dependencies and constraints

The following statements are assumed to be true:

1. Customers are not allowed to enter unless they have received a ticket or booked a visit.
2. Customers can get their ticket by either using their app or physical machines at the store, and in no other way. Visits can be booked by using the app, and in no other way.
3. The maximum number of people allowed to be in a store sector at the same time N is known.
4. Customers who book a visit and declare in advance their intended actions will respect their declarations, i.e. they will not visit sectors other than the declared ones. Customers who do not explicitly declare their intension might instead visit any store sector.
5. Customers who book separate visits/ get different tickets will not get in direct contact inside the store, thanks to some employees in charge of controlling their behaviour.
6. Access to the store by ticket (i.e. for queuing customers) is granted if and only if the customer's ticket number has been called and the next ticket number has not been called yet.
7. Every access point to the store or exit is monitored by one or more checkpoint controller who is in charge of preventing irregularities. In particular such employee will not permit multiple groups to enter at a time and will make sure that customers who exit do not get in contact with queuing/entering customers within the area of the store.
8. Customers enter one group at a time.
9. Each booking requires the specification of the number of people that will make the purchases within the same group.
10. A checkpoint controller will scan the QR codes of every customer in order to prove the validity of their ticket/booking. Customers holding an invalid ticket will be prevented from entering the store.
11. A customer can reach the store by foot, car or public transport. No other ways of getting to the store are considered.

# Specific requirements

3

Introductory text to the chapter (how it is subdivided and what are we going to say in the chapter)

## External interface requirements

### User interfaces

* **Customers web app:** offers the queueing, booking, and related functionalities.
* **Store managers web app:** offers a console where the manager can set store’s parameters like opening hours or sections
* **Checkpoint controllers web app:** accesses the user camera and scans the ticket’s QR code, showing on screen its validity
* **Ticket machine app:** very easy and basic UI with a button to print a ticket
* **Queue display web app:** shows the queue state of a store

### Hardware interfaces

The application does not have any hardware interface. This is because all the hardware services used like the GPS or the camera are accessed indirectly through the web browser, that then interacts with the operating system.

### Software interfaces

* **Web browser:** it is necessary to run the web app (descrivere)
* **Map service:** it is needed to estimate how much time the user will need to reach the store
* **DBMS:** it is used by the application to store and retrieve data to perform its main activities
* **Windows OS:** it is necessary to run the ticket machine app. It is chosen over the other OS because it is the most popular among ticket machines

### Communications interfaces

* **HTTPS:** the application will use this protocol to safely communicate over the internet

## Functional requirements

Use cases: Davide

### Use cases

#### Registration

Diagram

Description automatically generated

Registration involves a customer which is not already registered to the service. It must use the generic web application accessible to everyone and start registration filling the form.

#### Store manager sets parameters

Diagram

Description automatically generated

The modification of parameters done by the store manager passes through its web application, which is an important actor in this use case.

#### Notifications

Diagram

Description automatically generated

Notification is the process of the system intended to notify the user about a free slot or about the necessity of getting out to reach the grocery store in time.

#### Taking a ticket

Diagram

Description automatically generated

Taking a ticket is an activity involving three different actors of the S2B.

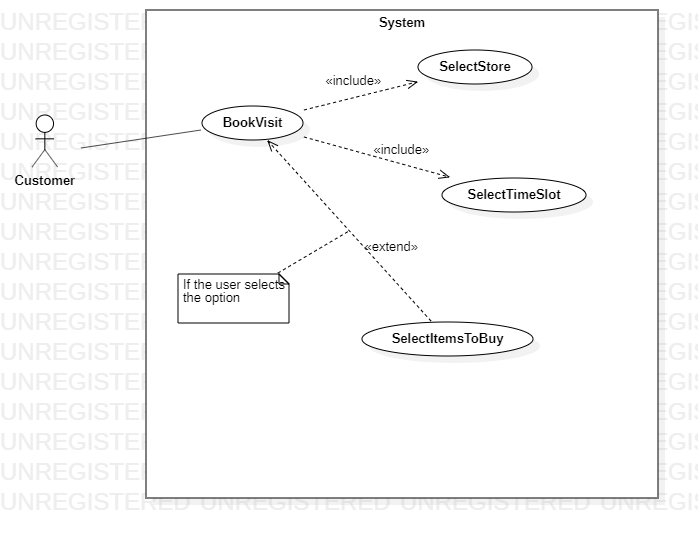
#### QR Code validation

Diagram

Description automatically generated

Taking a ticket is an activity involving only the customer and the checkpoint controller.

#### Visit booking



1. A user who wants to use the system online as a customer must register for free. Further uses require customers to login with valid credentials. Registration requires submitting a user name, a password, name, surname and birth date. However only the username and password couple is required in order to log in.
2. Store managers and checkpoint controllers need to log in as well, but their accounts are created by a sys-admin. Thus they do not need to register as store managers or controllers. (mapping)
3. After logging in, a user can only access the functionalities that are specific of their role.
4. The system will display a digital map with all the available stores in their area. Customers can select a store where they intend to make a purchase, among the displayed ones.
5. If a store was previously selected, customers can join a digital FIFO queue. After joining a queue, the system will send the user a digital ticket. A user can have at most one valid ticket for a given store at any time, i.e. it is not allowed to get another ticket for a store S while being in the digital queue for S. (mapping)
6. A digital ticket consists of a number representing the position in the queue and a QR code. For any two customers waiting in the same queue, their waiting numbers are not equal.
7. If a customer A is in a digital queue, the system will display an estimated waiting time t. Such time is such that the difference between t and the real time T should not exceed 5 minutes. (pensiamoci in seguito, formalizzare meglio)
8. When the estimated time calculated at point 7 is less or equal than the estimated travel time for a customer A, they will receive a notification telling them to reach the store.
9. If a customer wishes so, they can retrieve a paper printed ticket at the store. Such ticket is identical to a digital ticket for what concerns its validity constraints.
10. The system will “call” waiting numbers by displaying them on a monitor at the entrance of the store.
11. Assuming that at most N people are allowed to be in the store at the same time, and M people are currently in the store, the system will call N-M numbers sequentially. If N-M > 1, then the calls will have a temporal distance of two minutes in order to avoid the formation of crowds while entering the store. (aggiungere che la coda è solo per client singoli)
12. A non-scanned ticket is valid for store S if and only if it was issued for S and its number has not been called by S yet or if the call happened no longer than 2 minutes before. In any other case, the ticket is marked as invalid, and the next waiting number will be called.
13. A customer may also ignore the digital queue and book a visit for a store instead.
14. If the functionality specified at point 13 was selected, the system will display a time table on the customer’s device, plus a set of pre-calculated suggested visits. Each day is divided in time slots of equal length. The customer may either select a finite number of contiguous and free time slots for their visit, or one of the suggested visits.
15. Suggested time slots always have a total duration between 15 and 20 minutes.
16. In case the customer chooses to specify their own time interval, the total time they specify must not exceed a time limit established by the store manager. Furthermore, customers can only choose time slots that start and end after the opening time and before the closing time of the selected store.
17. While booking the user may input a list of items and categories of items that they intend to buy. Their app will show a list of categories and items that they can choose.
18. Finally, in order to validate the booking of a visit, the user must submit how they intend to reach the store, choosing from a fixed list of options. After doing that the system will send the user a QR code that certifies their booking.
19. The system will send a notification to the user who has successfully booked a visit T minutes before their due visit time. T is the expected travel time, and is set to the average travel time for the type of option that the user has selected as specified in the previous point.
20. A non-scanned QR code for a visit is valid for store S if and only if it was issued for S and either the selected time of arrival has not arrived yet or no more than 5 minutes have passed since the selected time of arrival.
21. Checkpoint controllers can scan a customer’s QR code upon letting them into the store. The system will check the validity of the code, and will display an error message if the token has lost its validity. After being scanned and approved, the token is marked as invalid, and thus cannot be reused for entrance.
22. A store manager who has previously logged in may set parameters for their store only. Such parameters are: the maximum number of people allowed in a store sector at the same time, the length of each time slot, the maximum permitted duration of a visit, opening and closing time of the store.
23. If a customer has used their app for longer than one month, the system will send them a notification once every two days. Such notification contains a list of 3 stores that are within their area and that have free time slots. The stores whose data is sent are always the 3 stores for which the sum of free time intervals at the time of sending is maximum.

### Requirements to goal mapping

Requirements must be mapped in the goals of the application. Goals must be granted given the domain assumptions and the requirements. Here there is a list of the mappings between the requirements and the goals of the application. We adopt the convention to identify the requirements with the format RN where N is the requirement number and GN is the goal number N:

|  |  |  |
| --- | --- | --- |
| R1 | G1, G2, G3, G4 | The listed goals can be reached only if the user is registered, if not they cannot be reached |
| R2 | G11 |  |
| R3 | G1, G2, G3, G4 |  |
| R4 | G1, G2 | If a customer wants to book a visit or to queue to a store to enter, he needs the presence of an object making him able to select the store |
| R5 | --- |  |
| R6 | G10 |  |
| R7 | G5 |  |
| R8 | G5, G6 |  |
| R9 | G13 |  |
| R10 | G12, G14 |  |
|  |  |  |
| R11 | G12, G13, G14 |  |
| R12 | G2 |  |
| R13 | G2, G3 |  |
| R14 | G3 |  |
| R15 | G2, G3 |  |
| R16 | G4 |  |
| R17 | G2 |  |
| R18 | G6 |  |
| R19 | G12, G13, G14 |  |
| R20 | G13 |  |
| R21 | G11 |  |
| R22 | G8, G9 |  |

## Performance requirements

## Design constraints

### Standard compliance

### Hardware limitations

### Any other constraint

## Software system attributes

### Reliability

### Availability

### Security

### Maintainability

### Portability

# Formal analysis using alloy

4

Introductory text to the chapter (how it is subdivided and what are we going to say in the chapter)

# Effort spent

5

This part is the part which summarize the effort spent by each member of the team in the documentation building process.

|  |  |
| --- | --- |
| **Davide Li Calsi** | |
| Introduction | 2hrs |
| Overall description | 3hrs |
| Requirements | 4hrs |
| Alloy | 0hrs |

|  |  |
| --- | --- |
| **Andrea Alberto Marchesi** | |
| Introduction | 1hrs |
| Overall description | 6hrs |
| Requirements | 0hrs |
| Alloy | 0hrs |

|  |  |
| --- | --- |
| **Marco Petri** | |
| Introduction | 2.5hrs |
| Overall description | 3.5hrs |
| Requirements | 3.5hrs |
| Alloy | 0hrs |

|  |  |
| --- | --- |
| **All** | |
| Meetings | 7hrs |

# References

6

Introductory text to the chapter (how it is subdivided and what are we going to say in the chapter)